BIOLOGICAL PARAMETERS

Lea et al. (1999) found the following relationships between length (TL, mm) and weight (grams) of blue rockfish in California

Combined sex:	$W = 0.000009774 * TL^{3.09}$	(1)
Males:	$W = 0.00002934 * TL^{2.889}$	(2)
Females:	$W = 0.00003408 * TL^{2.874}$	(3)

Echeverria and Lenarz (1984) provide the following length (mm) conversion equations we use in this assessment

FL = -2.164 + 0.962 (TL)	(4)
FL = 0.352 + 1.192 (SL)	(5)
TL = 2.495 + 1.039 (FL)	(6)

The units of length for this assessment are in fork length, so Equations 4 & 5 were used to convert all lengths to fork length. The length to weight relationships (male and female) can be seen in Figure 5.

Parturition and Recruitment

Mating of blue rockfish occurs in October, and eggs are fertilized a few months later. Parturition occurs from November to March, with a peak in mid-January (Lea et al. 1999, Reilly 2001). Larval blue rockfish spend a few months in the water column before settling (April-June) in nearshore rocky habitats when they are about 1.5 inches in length (Love et al. 2002). Annual recruitment is highly variable, and recruitment is negatively correlated with water temperature (Gundelfinger 2005). Year-class strength is dependent on physical factors occurring at the larval stage (Ralston and Howard 1995). Settlement numbers and spatial variability also depend on geographic features (Field and Ralston 2005) or oceanic conditions such as El Niño, which can lead to starvation of juveniles, increased exposure to predation, or diminished reproductive condition (VenTresca et al. 1995, Moser et al. 2000, Sakuma et al. 2006).

Age, growth and natural mortality

Maximum lifespan has been estimated to be 44 years for male blue rockfish and 41 years for females (Laidig et al. 2003), using otoliths and the break-and-burn technique for aging. Miller and Geibel (1973) reported the oldest fish to be 24 years of age; however, scales were used in this study for aging, which are not as reliable as otoliths. Blue rockfish attain a maximum length of 53 cm TL (50 cm FL, 21 in), with females growing slower but attaining larger sizes (Mason 1998, Love et al. 2002). Figure 6 shows the differences in growth between the sexes (Laidig et al. 2003).

Most studies have shown that growth of blue rockfish (among individuals, sexes, geographic areas and depths) is highly variable. Due to the wide variation among individuals, the residential behavior of blue rockfish in shallow water and the relatively slow growth, Miller and Geibel (1973) were not able to construct an age-length curve from aging data. We also found this difficult to accomplish for this assessment.

Based on maximum ages (Laidig et al. 2003) and Hoenig (1983), natural mortality was initially estimated at M = 0.10 for both males and females. Tenera (2000) reported natural mortality for blue rockfish to be 0.14. The model section discusses this in more detail.

Maturity and Fecundity

Half of blue rockfish males mature at about 10 inches (25.4 cm, 5-6 years) and females at 11 inches (27.9 cm, 6 years), although this can vary considerably (Miller and Geibel 1973, Reilly 2001). Wyllie Echeverria (1987) derived maturity estimates (0%, 50% and 100%) for both male and female blue rockfish. For females, the first size and age at maturity was determined to be 22 cm TL (19 cm FL) and 5 years old, 50% were mature at 29 cm TL (26 cm FL) and 6 years old, and 100% were mature at 35 cm TL (32 cm FL) and 11 years old. We used these estimates to fit the spawning ogive curve (converted to fork length, Equation 4) which can be seen in Figure 7. Laidig et al. (2003) concluded younger ages from their study. They found that 50% maturity for females was age 5 instead of age 6 and the youngest were mature at 3 years instead of 4 or 5. This could be the result of a change in size and age at maturity over time.

No size-specific fecundity equation has been published; however a female at 9.8 inches TL (25 cm) is estimated to produce about 50,000 eggs, where a 15.9 inch TL (40 cm) female can produce about 524,000 eggs (CDFG 2002). The spawning output by length used in the model also used a linear relationship derived from the two females whose fecundity was reported. Using this information and Equations 3 & 6, we determined the spawning output (eggs per kg) for female blue rockfish (Figure 8).